

REMARKS/ARGUMENTS***The Present Invention and the Pending Claims***

The present invention is directed to a process and an apparatus for obtaining a hydrogen product from a feed gas consisting essentially of an acid gas. Claims 1-34, 67, and 69 are directed to a process, whereas claims 35-66 and 69 are directed to an apparatus.

Summary of the Abstract and Claim Amendments

The abstract has been amended to reduce the overall number of words.

Claims 1 and 35 have been amended to recite “the feed gas consisting essentially of an acid gas.” Support for this amendment can be found in the specification at, for example, page 1, lines 21 - 29, page 5, lines 16 - 17, and page 27, lines 11 - 14. Claims 14, 18, 22, 42, 54, and 59 have been amended to delete the reference to the trademark FLEXSORB® and to claim “wherein the amine based reagent is comprised of an aqueous solution of a sterically hindered amine.” Support for this amendment can be found in the specification at, for example, page 30, lines 16 - 21. The second instance of claim 32 has been canceled and rewritten as new claim 67. New claims 68 and 69 have been added and are supported by the specification at, for example, page 6, lines 18 - 27 and page 28, lines 1 - 16.

No new matter has been added by way of these amendments.

Information Disclosure Statement

The Office acknowledged receipt of the Information Disclosure Statement that was filed July 9, 2004; however the publication dates were not properly indicated for References AM and AS, which were submitted with the application. As a result, the Office has not considered References AM and AS. Enclosed herewith is a supplemental Information Disclosure Statement indicating the missing publication dates for the above-identified references. Applicants hereby request that the Examiner consider the references cited therein (i.e., references AM and AS) and return to Applicants an initialed PTO-1449 form.

Summary of the Office Action

The Examiner has objected to the specification. Claims 14, 18, 22, 42, 54, and 59 have been rejected under 35 U.S.C. § 112, second paragraph, as allegedly indefinite. Claims 1, 2, 4, 5, 8-10, 13, 16, 25, 28-32, 35-38, 40, 41, and 45-51 have been rejected under 35 U.S.C. § 102(b) as allegedly anticipated by U.S. Patent No. 5,211,923 (Harkness et al.). Claims 1-16, 25, 28-32, and 35-51 have been rejected under 35 U.S.C. § 103(a) as allegedly obvious over Harkness et al. in view of “Fuels Technologies FLEXSORB® SE FLEXSORB® SE PLUS Environmental Technology” (from Exxonmobil’s website; hereinafter “the FLEXSORB® reference”) and U.S. Patent No. 5,681,540 (O’Brien). Finally, the Examiner states that the limitations of claims 17 – 24, 26, 27, 33, 34 and 52 – 66 are not taught or suggested by any of the references of record. Reconsideration of the pending claims is hereby requested.

Discussion of the Objection to the Specification

The Examiner has objected to the abstract for exceeding 150 words in length. In reply, the abstract has been amended, as set out above, in order to reduce its length. The abstract is now 138 words in length.

The Examiner has noted that there are “two Claim 32s” listed in the pending claims. In reply, the second instance of claim 32 has been canceled, and the subject matter of the claim has been re-introduced as new claim 67.

In view of these amendments, it is respectfully submitted that the objections to the specification have been fully addressed and overcome.

Discussion of the Indefiniteness Rejection

Claims 14, 18, 22, 42, 54 and 59 allegedly are indefinite, and in particular, for reciting the trademark “FLEXSORB®.” In reply, claims 14, 18, 22, 42, 54 and 59 have been amended to delete the reference to the trademark and to claim “wherein the amine based reagent is comprised of an aqueous solution of a sterically hindered amine,” as supported by the specification. In view of this amendment, the indefiniteness rejection has been overcome.

Discussion of the Anticipation and Obviousness Rejections

Claims 1, 2, 4, 5, 8, 9, 10, 13, 16, 25, 28 – 32, 35 – 38, 40, 41 and 45 – 51 allegedly are anticipated by Harkness et al. Claims 1 – 16, 25, 28 – 32 and 35 – 51 allegedly are obvious over Harkness et al. in view of the FLEXSORB® reference and O'Brien.

A. Applicants' Invention

The present invention as claimed in amended independent claim 1 is directed to a process for obtaining a hydrogen product from a feed gas consisting essentially of an acid gas, wherein the feed gas is comprised of hydrogen sulfide, the process comprising the following steps:

- (a) first separating the feed gas to obtain a first purified hydrogen sulfide fraction from the feed gas, wherein the first purified hydrogen sulfide fraction is comprised of at least about 90 percent hydrogen sulfide by volume;
- (b) dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction into elemental hydrogen and elemental sulfur to convert the first purified hydrogen sulfide fraction into a dissociated first purified hydrogen sulfide fraction, wherein the dissociated first purified hydrogen sulfide fraction is comprised of elemental hydrogen and elemental sulfur;
- (c) second separating the dissociated first purified hydrogen sulfide fraction to obtain a hydrogen rich fraction from the dissociated first purified hydrogen sulfide fraction, wherein the hydrogen rich fraction is comprised of elemental hydrogen; and
- (d) obtaining the hydrogen product from the hydrogen rich fraction, wherein the hydrogen product is comprised of elemental hydrogen.

Amended claim 35 is directed at an apparatus for obtaining a hydrogen product from a feed gas consisting essentially of an acid gas, wherein the feed gas is comprised of hydrogen sulfide, the apparatus comprising:

(a) a first separating apparatus for first separating the feed gas to obtain a first purified hydrogen sulfide fraction from the feed gas such that the first purified hydrogen sulfide fraction is comprised of at least about 90 percent hydrogen sulfide by volume;

(b) a dissociating apparatus for dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction into elemental hydrogen and elemental sulfur to convert the first purified hydrogen sulfide fraction into a dissociated first purified hydrogen sulfide fraction, wherein the dissociated first purified hydrogen sulfide fraction is comprised of elemental hydrogen and elemental sulfur;

(c) a second separating apparatus for second separating the dissociated first purified hydrogen sulfide fraction to obtain a hydrogen rich fraction from the dissociated first purified hydrogen sulfide fraction, wherein the hydrogen rich fraction is comprised of elemental hydrogen; and

(d) a third separating apparatus for third separating the hydrogen rich fraction to obtain the hydrogen product from the hydrogen rich fraction, wherein the hydrogen product is comprised of elemental hydrogen.

Page 1, lines 21 - 26 of the specification state:

“In this context, the term “sour gas” as used herein refers to a natural gas which contains quantities of methane and hydrogen sulfide, as well as one or more impurities or contaminants such as carbon dioxide. Further, the term “acid gas” as used herein refers to process gas or sour gas from which substantially all of the methane has been extracted, leaving hydrogen sulfide and carbon dioxide as the principal components. Methane is typically extracted from sour gas using conventional amine extraction processes known to those skilled in this area.”

In the preferred embodiment of Applicants’ invention, the feed gas consists essentially of acid gas. As defined by the specification, “the acid gas is comprised of hydrogen sulfide (H₂S) and carbon dioxide (CO₂)” (page 5, lines 16 - 17 and page 27, lines 11 - 14).

The feed gas, consisting essentially of acid gas, is first separated to obtain a first purified hydrogen sulfide fraction from the feed gas, wherein the first purified hydrogen sulfide fraction is comprised of at least about 90 percent hydrogen sulfide by volume. The

hydrogen sulfide present in the first purified hydrogen sulfide fraction is then dissociated into elemental hydrogen and elemental sulfur to convert the first purified hydrogen sulfide fraction into a dissociated first purified hydrogen sulfide fraction.

In order to facilitate the dissociation and to enhance the resulting product streams, the feed gas directed to the first separation consists essentially of acid gas. By providing a feed gas from which the methane has been substantially removed, significant energy need not be utilized to dissociate this undesirable compound. Further, the dissociation will result in a decreased production of various undesirable impurities or contaminants in the product streams. Finally, the first separation of the feed gas to obtain a first purified hydrogen sulfide fraction comprised of at least about 90 percent hydrogen sulfide by volume further enhances the purity or desirability of the product streams.

As stated at page 6, lines 9 - 27 of the specification:

“... preferably, the first purified hydrogen sulfide fraction is relatively “rich” such that it is comprised of a significant proportion or percentage of hydrogen sulfide. More preferably, in order to enhance the effectiveness of the process and to enhance the desirability of the hydrogen product resulting therefrom, the first purified hydrogen sulfide fraction is comprised of a minimum percentage of hydrogen sulfide by volume in a range of about 90 to 100 percent.

Thus, the first purified hydrogen sulfide fraction is preferably comprised of at least about 90 percent hydrogen sulfide by volume, although a percentage of hydrogen sulfide by volume of at least about 94 percent is even more preferable. Further, in order to maximize the effectiveness of the process and produce highly desirable hydrogen and sulfur products, the first purified hydrogen sulfide fraction is most preferably comprised of at least about 98 or 99 percent hydrogen sulfide by volume. In other words, the percentage of hydrogen sulfide by volume is preferably maximized, while minimizing and preferably eliminating any contaminants or other components in the first purified hydrogen sulfide fraction. Thus, in the preferred embodiment, the first purified hydrogen sulfide fraction is as “pure” as reasonably practicable, being comprised of as high a percentage of hydrogen sulfide by volume as is reasonably practicable.”

(See also page 28, lines 1 - 30 of the specification).

Further, the process and apparatus as claimed result in the obtaining of a hydrogen product. The “purity” of the first purified hydrogen sulfide fraction determines, at least in part, the “purity” of the hydrogen product. The specification states at page 29, lines 1 - 9:

“The particular proportion or percentage of elemental hydrogen comprising the hydrogen product (22) is dependent, at least in part, upon the purity of the first purified hydrogen sulfide fraction (32) or the percentage or proportion of hydrogen sulfide therein. Specifically, the greater the purity of the first purified hydrogen sulfide fraction (32), the greater the purity of the hydrogen product (22) which is achievable or obtainable by the within invention. Thus, the percentage or proportion of hydrogen sulfide in the first purified hydrogen sulfide fraction (32) is selected in order to obtain or achieve the desired target percentage or proportion of elemental hydrogen in the hydrogen product (22), which is preferably at least about 95 % by volume of elemental hydrogen.”

B. Anticipation Rejection in view of Harkness et al.

Harkness et al. does not disclose first separating the “feed gas consisting of acid gas” to obtain a first purified hydrogen sulfide fraction comprised of at least about 90 percent hydrogen sulfide by volume and dissociating the first purified hydrogen sulfide fraction. Referring to Figure 2 of Harkness et al., column 3, lines 33 - 36 of Harkness et al. state:

“a sour gas from hydrodesulfurizer 10 (including an amine purification) containing hydrogen sulfide in the general range of about 30 to 99% is fed to plasma reactor 12.”

The only additional description provided regarding the composition of the “sour gas” is provided at column 5, lines 14 - 27 of Harkness et al. which states that the “sour gas feed in FIGS. 2 - 3” includes “a H₂O content of about 5% in the sour gas” and a CO₂ content “from as low as 5% to as high as 60%,” with the balance of the stream being “hydrogen sulfide with, perhaps, a trace of hydrocarbons.” Based upon these percentages (i.e., 10 - 65% of the sour gas is comprised of H₂O and CO₂), the hydrogen sulfide content of the “sour gas” is calculated to be about 35% to 90% of the sour gas.

No further description is provided by Harkness et al. of the nature of the feed to the hydrodesulfurizer (10) or the plasma reactor (12).

In addition, referring to Figure 2 of Harkness et al., two feed streams are provided to the plasma reactor (12) for dissociation.

With respect to a first feed stream, Figure 2 of Harkness et al. depicts a line marked “sour gas” being fed to recycle line (14), which is conducted directly to the plasma reactor (12). In other words, this feed gas is “sour gas” which is fed directly to the plasma reactor. As described previously, “sour gas” refers to a natural gas which contains quantities of methane and hydrogen sulfide, as well as one or more impurities or contaminants such as carbon dioxide. Further, as defined by Harkness et al., “sour gas” includes 35% - 90% hydrogen sulfide.

As a result, the “feed gas” (“sour gas”) conducted to line (14) of Harkness et al. **does not consist essentially of “acid gas”**, as claimed by Applicants. As well, the “feed gas” **is not comprised of at least 90% hydrogen sulfide by volume**. Finally, in any event, the “feed gas” of Harkness et al. provided to line (14) is **fed directly to the plasma reactor without any intervening steps**. In other words, Harkness et al. does not describe or disclose “first separating the feed gas to obtain a first purified hydrogen sulfide fraction from the feed gas” and “dissociating the hydrogen sulfide present in the first purified hydrogen sulfide fraction”, as required by independent claims 1 and 35. In this first feed stream, Harkness et al. simply dissociates the sour gas.

With respect to a second feed stream, as shown in Figure 2 and as described at column 2, lines 33 - 34, Harkness et al. depicts “a sour gas from hydrodesulfurizer 10 (including amine purification).” No further description is provided regarding the nature of the “hydrodesulfurizer”, the “amine purification” or the composition of the gas stream to the hydrodesulfurizer.

The Examiner suggests that the hydrodesulfurizer teaches a sour gas stream fed into an amine purification unit, which “separates the sour gas into a hydrogen sulfide-containing gas having a hydrogen sulfide concentration ranging from 30 - 99%.” Thus, it appears that the Examiner is equating the “sour gas” with Applicants’ claimed “feed gas.” Further, it appears that the Examiner is equating the “hydrodesulfurizer” with Applicants’ claimed “first separating apparatus” for first separating the feed gas.

However, as indicated, the “feed gas” conducted to the hydrodesulfurizer (10) of Harkness et al. is sour gas, and **does not consist essentially of “acid gas,”** as claimed by

Applicants. Rather, it is submitted that the hydrodesulfurizer (10) and amine purification described by Harkness et al. are provided to produce acid gas from the sour gas.

As described in the present application at page 1, lines 25 - 26, "Methane is typically extracted from sour gas using conventional amine extraction processes known to those skilled in this area." Accordingly, it is submitted that the reference to "amine purification" as part of the hydrodesulfurizer (10) refers to the extraction of methane from the sour gas, resulting in the production of "acid gas," as defined by Applicants. As described by Harkness et al., the "acid gas" produced by the hydrodesulfurizer (10) and amine purification has a hydrogen sulfide concentration ranging from 30 - 99%.

Thus, as claimed by Applicants, the feed gas consists essentially of acid gas, which is first separated to obtain a first purified hydrogen sulfide fraction. The first purified hydrogen sulfide fraction is then dissociated. The acid gas is not dissociated, rather the product obtained from the first separation of the acid gas is dissociated.

In clear contrast, as described by Harkness et al., the feed gas is a sour gas, which undergoes amine purification to provide acid gas. The acid gas is then dissociated. The acid gas of Harkness et al. is fed directly to the plasma reactor without any intervening steps. Thus, Harkness et al. does not describe or disclose "first separating the feed gas (consisting essentially of acid gas) to obtain a first purified hydrogen sulfide fraction from the feed gas" and "dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction."

Further, in the present invention, the first separating of the "feed gas" consisting essentially of acid gas is performed in order to provide a specified first purified hydrogen sulfide fraction for dissociation. In particular, the first purified hydrogen sulfide fraction to be dissociated is comprised of at least about 90% hydrogen sulfide by volume.

Referring to Harkness et al., the feed stream to be dissociated is directed to the plasma reactor with no particular care or concern for its composition, and in particular, with no care or concern for the percentage of hydrogen sulfide contained in the feed stream. Specifically:

- "Sour gas" is conducted by Harkness et al. directly to the plasma reactor (12) through line (14), without any intervening steps or apparatus to obtain a desired percentage of hydrogen sulfide therein.

- Column 5, lines 14 - 27 of Harkness et al. indicates that the hydrogen sulfide content of the “sour gas” of Figures 2 - 3, which is dissociated in the plasma reactor, is about 35% to 90% of the sour gas. Harkness et al. states that “this gas can be piped directly to a plasma reactor.”
- Other than the general description of “sour gas” set out above, no description is provided by Harkness et al. regarding the hydrogen sulfide content of the “sour gas” conducted to the hydrodesulfurizer (10) for amine purification.
- The gas stream produced by amine purification of the “sour gas” by the hydrodesulfurizer (10) is an “acid gas.” The acid gas is conducted directly to the plasma reactor (12) without any intervening steps or apparatus to refine the hydrogen sulfide content of the acid gas prior to dissociation.
- The acid gas conducted to the plasma reactor (12) for dissociation contains hydrogen sulfide “in the general range of about 30 to 99%.” It is submitted that this extremely broad range of hydrogen sulfide content does not disclose Applicants’ claimed percentage “of at least about 90% hydrogen sulfide” with sufficient specificity to be anticipated thereby. Rather, the breadth of the range of Harkness et al. clearly suggests that the hydrogen sulfide content is unimportant when performing the subsequent dissociation.
- Furthermore, as discussed below, Applicants’ claimed range relates to the hydrogen sulfide content of the first purified hydrogen sulfide fraction which is dissociated. The range specified by Harkness et al. of “about 30 to 99%” relates to the hydrogen sulfide content of the acid gas only. However, the acid gas of Harkness et al. is combined with sour gas in the plasma reactor. Accordingly, the specified range does not relate to the hydrogen sulfide content of the gas which is dissociated by the plasma reactor.
- Figure 2 of Harkness et al. shows that two feed streams are provided to the plasma reactor (12) for dissociation: from line (14) and from the hydrodesulfurizer (10). There is no description or discussion whatsoever regarding the relative contributions of the feed streams or the composition of

the combined feed streams fed to the plasma reactor for dissociation.

Accordingly, it is impossible to determine the hydrogen sulfide content of the gas stream being dissociated within the plasma reactor of Harkness et al. In contrast, Applicants clearly claim “dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction” which is comprised of at least about 90% hydrogen sulfide by volume.

As described in detail above, the “feed gas” of amended claims 1 and 35 consists essentially of acid gas, which is not fed directly to the “dissociating step” or “dissociating apparatus” (i.e. the plasma reactor). The composition of the gas fed to the dissociating step or apparatus is of importance to the present invention for the reasons set forth above. Accordingly, Applicants’ invention provides a first separating step/first separating apparatus to obtain a “**first purified hydrogen sulfide fraction**” having a specified **hydrogen sulfide content of at least about 90% by volume**. The first purified hydrogen sulfide fraction is then dissociated.

In other words, an “intermediate step” is provided between the production of the acid gas and the dissociation by the plasma reactor in order to ensure that the hydrogen sulfide content of the “first purified hydrogen sulfide fraction” fed to the plasma reactor is at least about 90% by volume, and preferably at least about 94%. As discussed previously, the specified percentage of hydrogen sulfide is required in order to enhance the effectiveness of the performance of the plasma reactor and to achieve the desired hydrogen product.

In order to anticipate a claim, the reference must teach each and every element of the claim (U.S. Manual of Patent Examining Procedure “MPEP” §2131). It is respectfully submitted that Harkness et al. does not teach each and every element of at least independent claims 1 and 35 for the reasons set forth above. Therefore, it is respectfully submitted that at least claims 1 and 35 are not anticipated by Harkness et al.

C. Obviousness Rejection in view of Combination of Harkness et al., the FLEXSORB® Reference, and O’Brien

In addition, as indicated above, the Examiner has rejected independent claims 1 and 35 as obvious over the combination of Harkness et al., the FLEXSORB® reference, and

O'Brien. However, the FLEXSORB® reference is only cited against dependent claims 14 and 42, while O'Brien is only cited against dependent claims 3, 6, 11 and 39.

In other words, with respect to amended independent claims 1 and 35, only Harkness et al. has specifically been applied to the claims as rendering the claims unpatentable. In reviewing the Office Action, it appears that the Examiner's rejection is based wholly or largely upon the view that all of the features of claims 1 and 35 are anticipated by Harkness et al.

However, as outlined above in detail, it is respectfully submitted that Harkness et al. does not teach or suggest every element of amended independent claims 1 and 35. Further, there is no description, suggestion or guidance provided by Harkness et al. relating to the missing elements, as detailed above. Moreover, the FLEXSORB® reference and O'Brien do not remedy the aforesaid deficiencies of Harkness et al. Thus, even if combined, the cited references do not disclose every element of independent claims 1 and 35.

As a result, it is respectfully submitted that at least amended independent claims 1 and 35 are not rendered unpatentable by Harkness et al.

D. Summary

In view of the foregoing, it is respectfully submitted that Harkness et al., either alone or in combination with the other cited references, does not teach, disclose or suggest the process or apparatus, as recited in amended independent claims 1 and 35. Further, dependent claims 2 - 34 and 67 - 68 depend directly or indirectly from amended independent claim 1, while dependent claims 36 - 66 and 69 depend directly or indirectly from amended independent claim 35. Thus, it is respectfully submitted that these dependent claims are allowable for the distinctions defined therein as well as for the reasons supporting the allowability of claims 1 and 35. Accordingly, pending claims 1-69 are novel and unobvious in view of the cited references, and these rejections should be withdrawn.

Conclusion

Applicants respectfully submit that the patent application is in condition for allowance. If, in the opinion of the Examiner, a telephone conference would expedite the

prosecution of the subject application, the Examiner is invited to call the undersigned attorney.

Respectfully submitted,

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